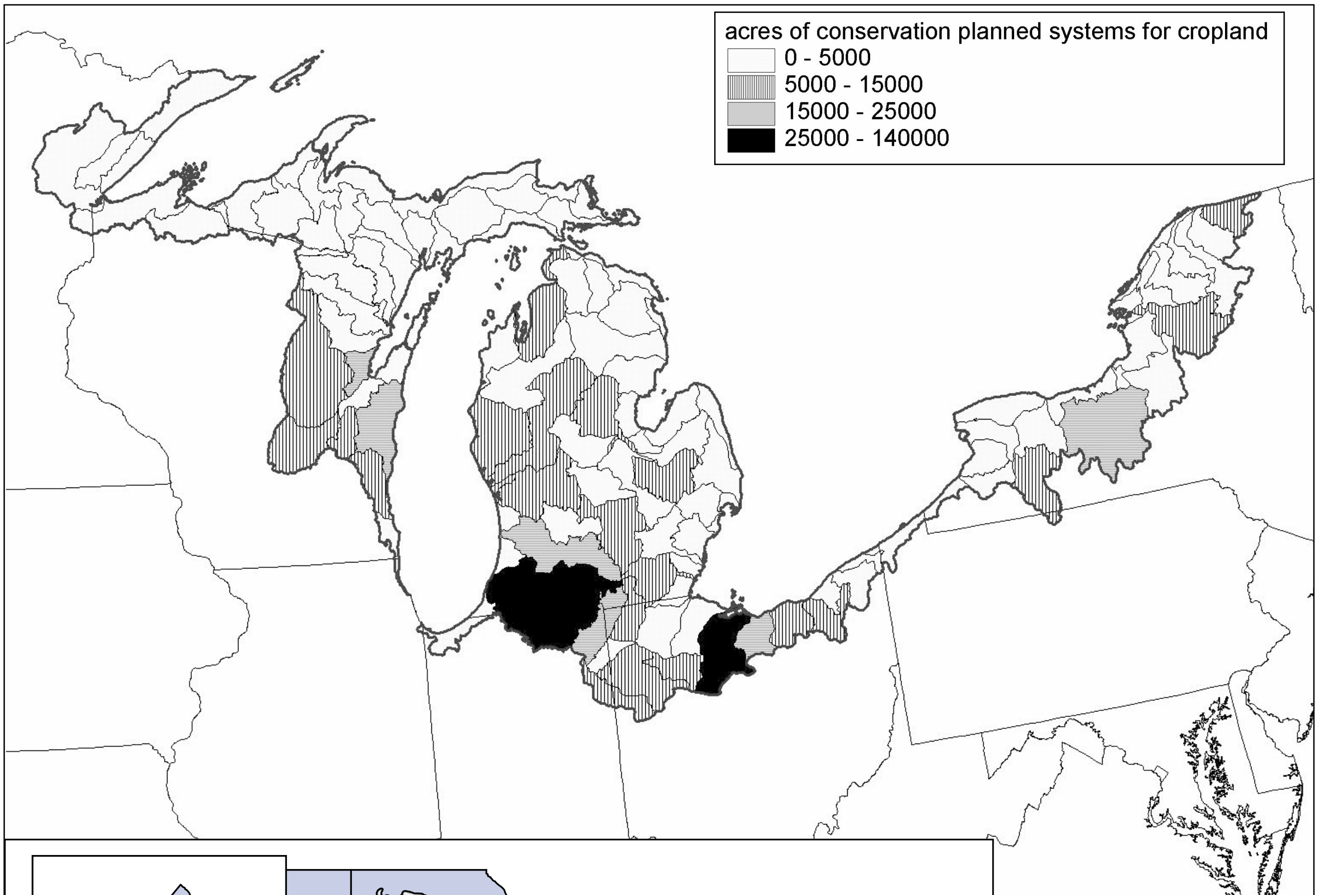
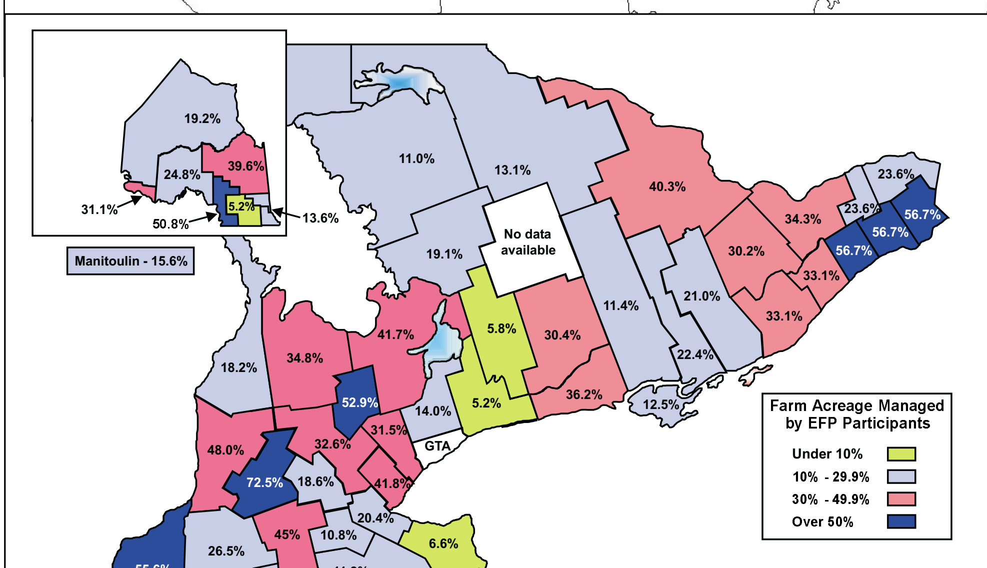


Annual U.S. conservation planned systems for 2000.

Source: U.S. Department of Agriculture, NRCS, Performance and Results Measurement System



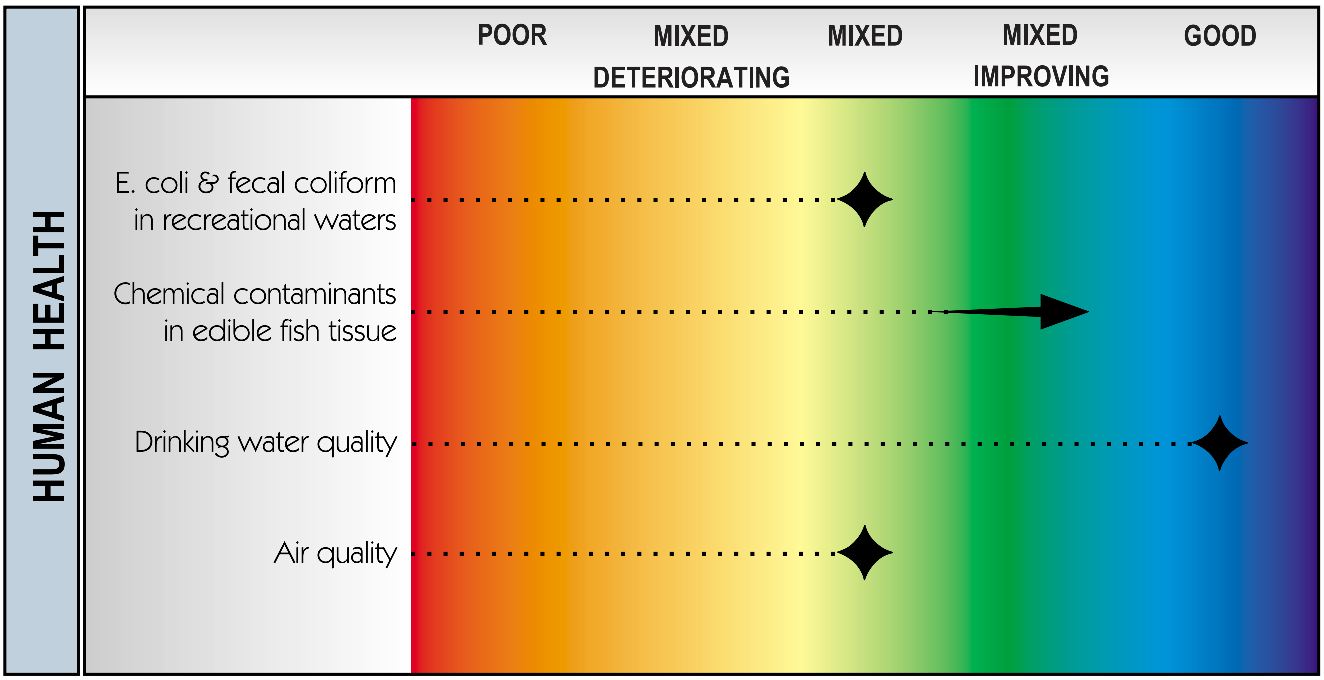
Ontario Statistics	#	Acres
Registered Farm Businesses:	56,500	13 million acres
EFP Participants:	15,000	4.4 million acres
Farmers with Peer Reviewed EFP Action Plans:	7,800	2.7 million acres

Ontario Environmental Farm Plan (EFP).

Source: Ontario Soil and Crop Improvement Association, April 1999, 1997 Ontario farm registration database, 1996 Census of Agriculture

3.5 Human Health

Human Health Indicators - Assessment at a Glance

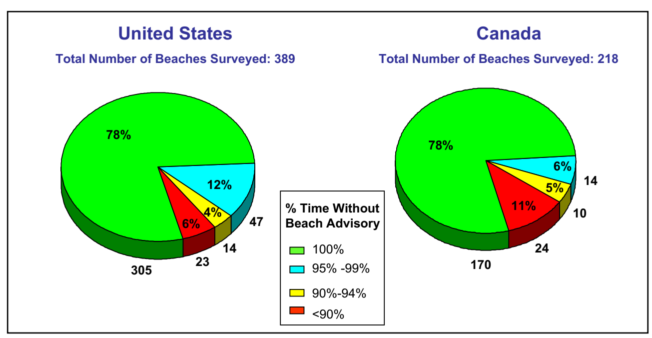


E. coli and Fecal Coliform in Recreational Waters

Assessment: Mixed

Purpose
This indicator assesses *E. coli* and fecal coliform contamination levels in nearshore recreational waters, acting as a surrogate indicator for other pathogen types, and it is used to infer potential harm to human health through body contact with nearshore recreational waters.

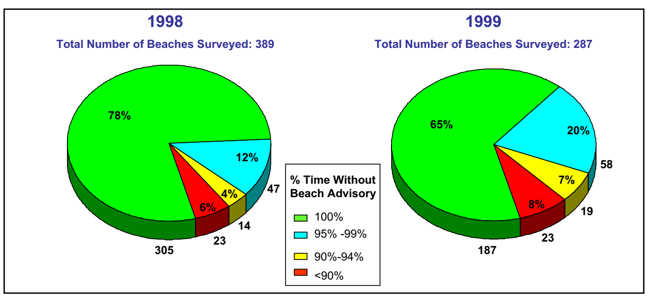
State of the Ecosystem
Survey reports of U.S. beach advisories during the 1998 swimming season (June, July, August) show that 78% of the reporting beaches were open for the entire 1998 season. Results were similar for Canadian beaches where 78% of the reporting beaches were open the entire season.



Comparison of U.S. and Canadian beach advisories for Great Lakes beaches, 1998.
Source: U.S. Environmental Protection Agency Beach Watch Program, National Health Protection Survey of Beaches for Swimming (1998) and Ontario Ministry of Environment

Survey reports of U.S. beach closings or advisories during the 1999 season show that 65% of the reporting beaches were open for the entire 1999 season. Several factors may have influenced the apparent increase in percentage of beach closings in 1999 compared with 1998:

- Fewer beach managers responded to survey questionnaires in 1999, and of those beaches that were reported, not all had been included in the 1998 data;
- More beach managers were using *E. coli* testing in 1999 than in 1998. *E. coli* is a more sensitive indicator of public health risks for swimmers, and it gives more consistent results. U.S. jurisdictions have begun to adopt uniform testing procedures for *E. coli* in the water at swimming beaches. This is an improvement over past methods and will provide more accurate information about potential risks to human health from swimming. While the actual water quality near beaches may not have changed, this new method may result in more beach advisories in the future; and
- A different accounting for the number of beach advisory days was used in 1999. For example, a two day episode of elevated bacterial levels in 1998 would have counted as one beach advisory.



U.S. beach advisories for Great Lakes beaches, 1998 vs. 1999.

Source: U.S. Environmental Protection Agency Beach Watch Program, National Health Protection Survey of Beaches for Swimming (1998)

Future Pressures

Population growth causing both increased demands made on sewage treatment plant capacities and the probability of release of untreated effluent, as well as more private treatment systems, especially in resort/vacation areas, may cause an increase of undetected releases of inadequately treated waste.

Acknowledgments

The following personnel contributed data, analysis, or reporting expertise to this indicator:

David Rockwell, Paul Bertram, and Wade Jacobson (SEE Program), U.S. Environmental Protection Agency, Great Lakes National Program Office, Chicago, Illinois. Richard Whitman, U.S. Geological Survey, Lake Michigan Ecological Research Station, Porter, Indiana. Marcia Jimenez, City of Chicago, Chicago, Illinois. Duncan Boyd and Mary Wilson, Ontario Ministry of Environment, Environmental Monitoring and Reporting Branch, Toronto, Ontario. Peter Gauthier, City of Toronto, Environmental Health Services, Toronto, Ontario.

Chemical Contaminants in Edible Fish Tissue

Assessment: Mixed, improving

Purpose

This indicator assesses the concentration of persistent, bioaccumulating, toxic (PBT) chemicals in Great Lakes fish, and it is used to infer the potential exposure of humans to PBT chemicals through consumption of Great Lakes fish caught via sport and subsistence fishing. This will be accomplished using fish contaminant data and a standardized fish advisory protocol. The approach is illustrated using the Great Lakes protocol for PCBs as the standardized fish advisory benchmark applied to historical data to track trends in fish consumption advice.

State of the Ecosystem

Fish Consumption Advisory Programs are well established in the Great Lakes. States, tribes, and the province of Ontario have extensive fish contaminant monitoring programs and issue advice to their residents about how much fish and which fish are safe to eat. Advice from these agencies to limit consumption of fish is related to levels of PCBs, mercury, chlordane, dioxin, and toxaphene in the fish, but vary by lake.

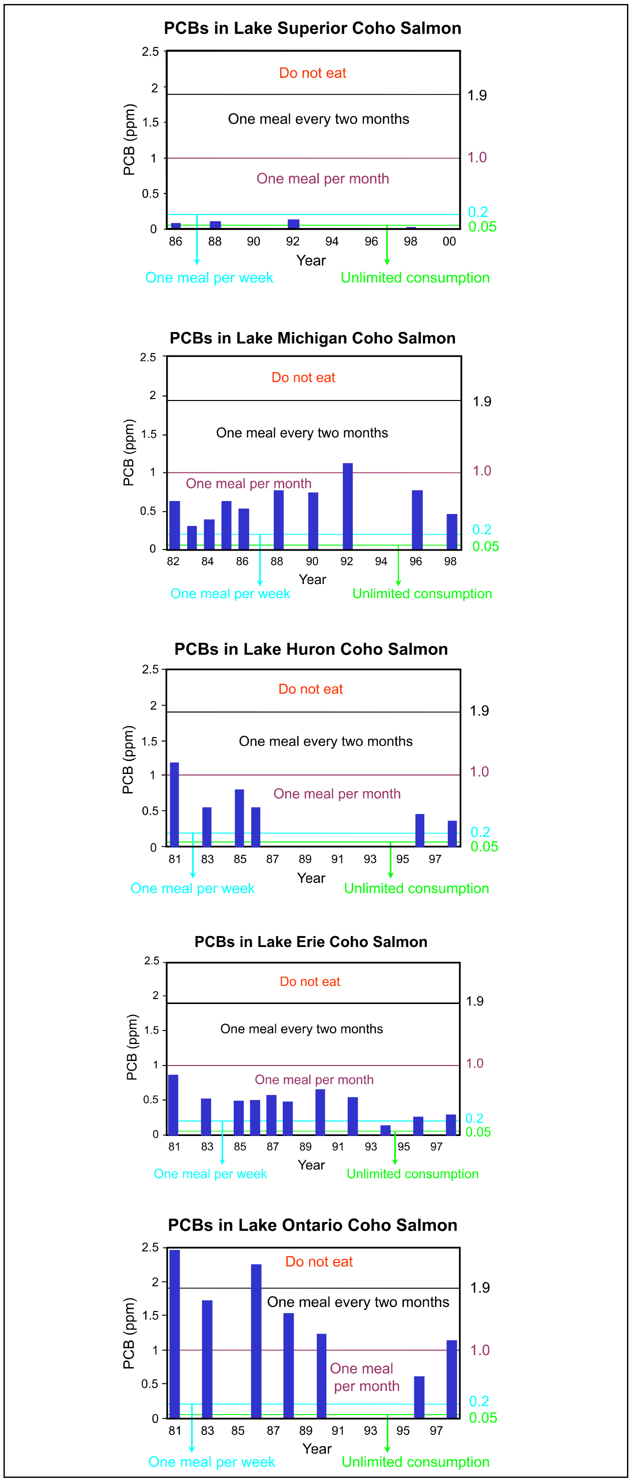
The accompanying figures illustrate the results of applying a uniform fish advisory protocol to historical data on PCBs in coho salmon fillets. The resulting advisories do not necessarily reflect actual advisories issued in each lake basin.

Future Pressures

Fish consumption advisories will still be required because of organochlorine contaminants, although these are generally decreasing. Mercury, the health effects of multiple contaminants, and endocrine disruptors are also of concern.

Acknowledgments

Authors: Patricia McCann, Minnesota Department of Health, and Sandy Hellman, U.S. Environmental Protection Agency, Great Lakes National Program Office.



Results of a uniform fish advisory protocol applied to historical data (PCBs, coho salmon) in the Great Lakes.

Source: Sandy Hellman, U.S. Environmental Protection Agency, Great Lakes National Program Office

Drinking Water Quality

Assessment: Good

Purpose

This indicator evaluates the chemical and microbiological contaminant levels in drinking water. It also assesses the potential for human exposure to drinking water contaminants and the effectiveness of policies and technologies to ensure safe drinking water.

State of the Ecosystem

There are many facets of drinking water, however this report focuses mainly on raw water from the Great Lakes proper.

At present, data from 22 sites around the basin have been assessed. The parameters used include both microbiological and chemical contaminants in raw water. Taste and odour, however, are most appropriately measured in treated water. The chemical parameters chosen were atrazine, nitrate and nitrite. These chemicals are seasonal and flow dependent. While minimal levels of atrazine, nitrate and nitrite were detected in raw water, monthly averages and maximums fell below the federal regulations for treated water. However, it should be noted that although atrazine seasonally enters the lakes by way of tributaries, this pattern was not detected at the 22 intakes included here.

Turbidity was chosen as a parameter for its correlation with potential microbial problems. High turbidity can interfere with disinfection and provide a medium for microbial growth. Turbidity values vary depending on season, location and lake. There are no raw water maximum levels for turbidity. However, by sampling raw water turbidity levels, the treatment plants can adjust treatment for optimal removal of microbial contaminants.

The level of organic matter can be determined by examining Total Organic Carbon (TOC) or Total Dissolved Organic Carbon (DOC). The DOC concentrations in raw water at the Canadian sites were fairly low, as was TOC at the majority of U.S. sites.

Taste and odour is a complex indicator. While it is an extremely important indicator to consumers, it is

U.S. and Canadian water treatment plants used in this report.

also difficult to quantitatively measure. Not all of the chosen water treatment sites had taste and odour data readily available. This indicator was evaluated for August 1999 at the six sites where data were available. Testing is done in August, since increased odour problems are usually associated with increased water temperatures. There were minimal problems with taste and odour at the six water treatment facilities that reported this parameter.

The microbiological indicators suggested are total coliform, *Escherischia coli*, *Giardia lambalia*, and *Cryptosporidium parvum*. The methods of analyzing water for *Giardia lambalia* and *Cryptosporidium parvum* are not the most reliable at this time, but it is suggested that these remain indicators as better methods become available. *Escherischia coli* is only tested when tap water tests positive for total coliform. Total coliform is probably the best choice for a microbial indicator at this time because it is the most uniformly tested. It is a required test in the U.S. and Canada. At the U.S. sites there have been no total coliform exceedances for the last ten years. While the total coliform data were available for the Canadian sites, there presently is no user-friendly method for exceedance interpretation.

The health of the Great Lakes, as determined by these drinking water parameters at these 22 sites, is good. Chemical contaminants are consistently tested to be at minimal levels even prior to treatment. Additionally, violations of these chemical and microbial parameters are extremely rare. The risk of human exposure to contaminants is low. The quality of drinking water as it leaves the water treatment plants meets standards. The quality of water delivered, however, can vary due to the possibility of contaminants entering the distribution system.

Future Pressures

Pressures that could compromise the quality of drinking water include land use and agricultural runoff; increases in both algal presence and water temperatures; byproducts of the drinking water disinfection process; and aging distribution systems.

Acknowledgments

This report was assembled by Molly Madden (Environmental Careers Organization), with the assistance of Rod Holme (American Water Works Association), Pat Lachmaniuk (Ontario Ministry of Environment), Tom Murphy (U.S. Environmental Protection Agency, Region 5), and Paul Bertram (U.S. Environmental Protection Agency, GLNPO). Additional thanks are due to the water treatment plant operators and managers who submitted the requested data.

Air Quality

Assessment: Mixed

Purpose

This indicator assesses the air quality in the Great Lakes ecosystem, and it is used to infer the potential impact of air quality on human health in the Great Lakes basin.

State of the Ecosystem

Overall, there has been significant progress in reducing air pollution in the Great Lakes basin. For most substances of interest, both emissions and ambient concentrations have decreased over the last ten years or more. However, progress has not been uniform and differences in weather from one year to the next complicate analysis of ambient trends. Ozone can be particularly elevated during hot summers. Drought conditions result in more fugitive dust emissions from roads and fields, increasing the ambient levels of particulate matter.

The pollutants have been divided into urban (or local) and regional pollutants for this report. Mention of the U.S. or Canada in this discussion refers to the respective portions of the Great Lakes basin. Latest published air quality data are for 1997 (Canada - Ontario) and 1999 (U.S.).

Urban/local pollutants include carbon monoxide (CO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), lead, total reduced sulphur (TRS) and particulate matter. In general, there has been significant progress with urban/local pollutants over the past decade or more, though somewhat less in recent years, with a few remaining problem districts. For example, in Canada average ambient NO_2 levels have remained relatively constant through the 1990s, however the only year without exceedances of the ambient criteria was in 1997. In the U.S, for both SO_2 and particulate matter (with diameter of 10 microns or less), there are six regions that do not meet ambient criteria. Emissions in Canada of SO_2 have increased slightly in the last two years of the period and ambient levels have only shown a slight decrease in the 1990s.

For regional pollutants, transport is a significant issue, from hundreds of kilometres to the scale of the globe. Formation from other pollutants, both natural and man-made, can also be important. There are still short periods each year during which regional pollutants (primarily ozone and fine particulates and related pollutants - collectively called smog) reach levels of concern, essentially in southern and eastern portions of the basin. Regional pollutants include ground level ozone (O_3), fine particulate matter, and air toxics. Ozone is a problem pollutant over broad areas of the Great Lakes basin (except Lake Superior). Local circulations around the Great Lakes can exacerbate the problem: high levels are found near Lakes Huron and Erie, even in areas such as in provincial parks that are well removed from local industry, and western Michigan is strongly impacted by transport across Lake Michigan from Chicago. Fine particulate matter (diameter 2.5 microns or less) is a health concern as it can penetrate deeply into the lung. In Canada, available data indicate that many locations in Southern Ontario will exceed the recently endorsed standard of 30mg/m^3 (24-hour average). In the U.S., there are not enough years of data to determine trends, but it appears that there may be many areas which do not attain the new U.S. standard. Air toxics of interest include those that have potential to harm human health (e.g. cancer), based on the toxicity and likelihood for exposure. Some ambient trends have been found: in the U.S. concentrations of benzene and toluene have shown significant decreases from 1993-1998, notably in the Lake Michigan region. Styrene has also shown a significant decrease (1996-1998).

Future Pressures

Continued population growth and associated urban sprawl are threatening to offset emission reduction efforts and better control technologies, both through increased car-travel and energy consumption. Climate change may affect the frequency of weather conditions leading to high ambient concentrations of many pollutants. Evidence exists of changes to the atmosphere as a whole. Average ground-level ozone concentrations may be increasing on a global scale.

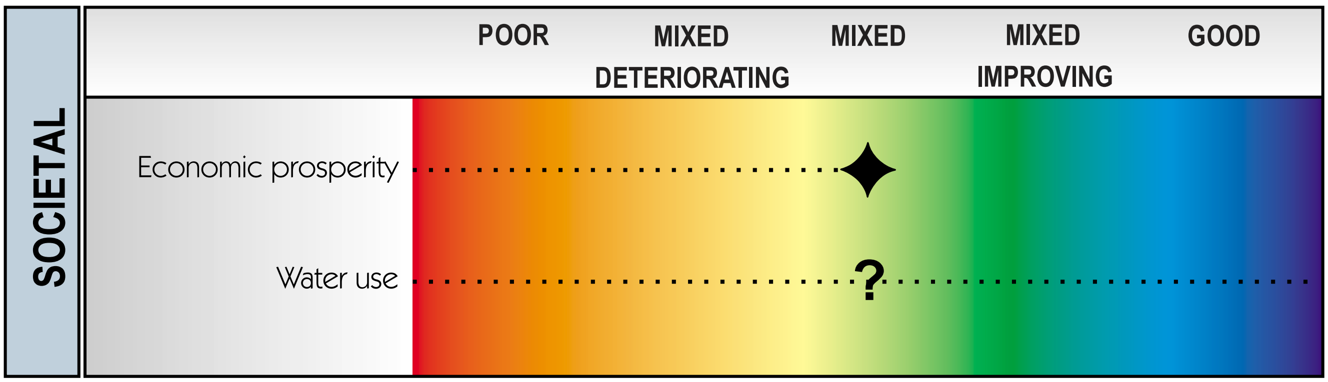
Continuing health research is both broadening the number of toxics of potential concern, and producing evidence that some existing standards should be reconsidered. There is epidemiologic evidence of health effects from ozone or fine particulates at or below levels previously considered to be background or "natural" levels.

Acknowledgments

Authors: Fred Conway, Environment Canada, Meteorological Services of Canada, Downsview, ON and Joseph Chung, U.S. Environmental Protection Agency, Air Division, Chicago, IL.

3.6 Societal

Societal Indicators - Assessment at a Glance



Economic Prosperity

Assessment: Mixed

Purpose
This indicator assesses the unemployment rates within the Great Lakes basin, and, when used in association with other Societal indicators, infers the capacity for society in the Great Lakes region to make decisions that will benefit the Great Lakes ecosystem. During periods of low unemployment (i.e. economic well-being), public support for environmental initiatives by government agencies and elected officials may be increased.

State of the Ecosystem
By most measures, the binational Great Lakes regional economy is healthy. The unemployment rate for the Great Lakes states dipped below the U.S. average in 1991 and remained there during the 1990's and, for the Great Lakes states collectively, unemployment is at a 30 year low. Canadian and Ontario economic recoveries unfolded later than the U.S. but have now nearly caught up. Ontario unemployment rates are currently at the lowest level since 1990.

Both sides of the border reflect a manufacturing intensity greater than their national economies. The Great Lakes states represent about 27% of national output in manufacturing whereas Ontario is twice as large. The manufacturing sector has many cross-border linkages particularly for the auto industry. About half of the billion dollar-a-day U.S.-Canada trade is tied to the Great Lakes states with Ontario as the most prominent province in this relationship.

Future Pressures
Good economic times translate into high levels of consumer spending and home buying. This may cause increased household and business waste generation, increased air pollution, and accelerated land use changes.

Acknowledgments
Authors: Steve Thorp, Great Lakes Commission, Ann Arbor, MI, Tom Muir, Environment Canada, Burlington, ON and Mike Zegarac, Environment Canada, Burlington, ON.

Water Use

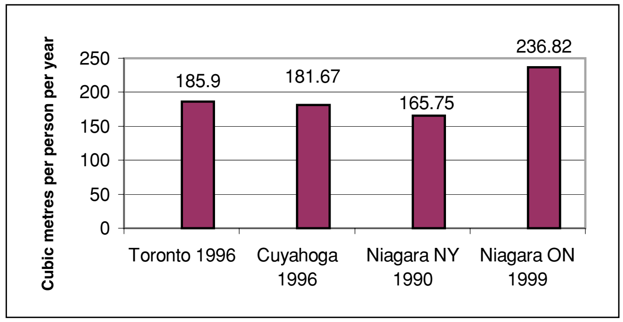
Assessment: Unable to assess status until targets are determined

Purpose
This indicator measures the amount of water used by residents of the Great Lakes basin. It also indirectly measures the stress to the Great Lakes ecosystem caused by the extraction of this water and the generation of wastewater pollution (there is a direct relationship between the amount of water used and the quantity and quality of wastewater discharged).

State of the Ecosystem
Water use was compared between four sample sites. These included two larger urban cities, Toronto, Ontario and Cuyahoga County, Ohio (which includes Cleveland) and two smaller communities, the Regional Municipality of Niagara, Ontario and Niagara County, New York. Generally, there are not great differences amongst the Great Lakes basin communities in terms of water use per capita, although the Regional Municipality of Niagara, Ontario appears to be using more per capita (by approximately 50 cubic metres each year) than the other municipalities studied. The larger urban communities of Toronto, Ontario and Cuyahoga, Ohio exhibited similar water use patterns per capita. The largely rural community of Niagara County, New York had the lowest per capita water usage rates of the sample, although a bias was possible since there were a small number of residents that were using ground water (and therefore, water use was not recorded).

Future Pressures
As Great Lakes populations grow, there will be increasing demand for water for all purposes.

Acknowledgments
Authors: Ray Rivers, Rivers Consulting, Campbellville, ON and John Barr, Burlington, ON.

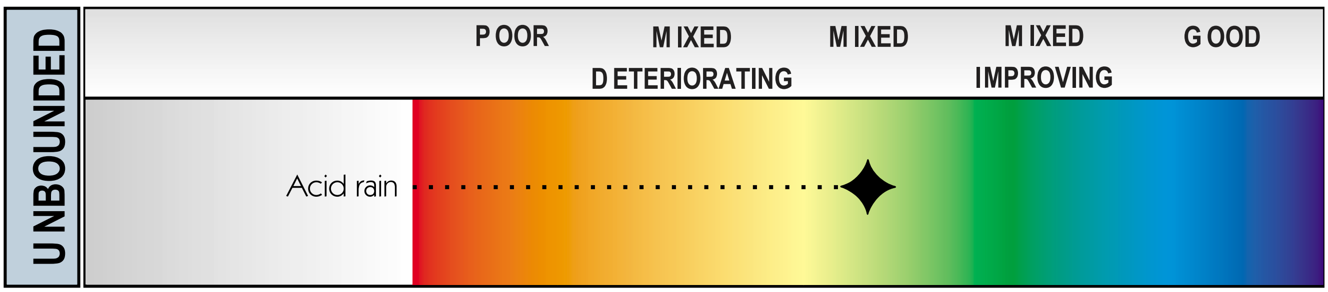


Water use rates of four communities in the Great Lakes basin.
Source: Rivers Consulting and J. Barr Consulting

3.7 Unbounded

Some of the Great Lakes indicators do not fit neatly into any of the other ecological categories. These indicators may have application to more than one category or they may reflect issues that affect the Great Lakes but have global origins or implications. One such indicator, acid rain, is included here.

Unbounded Indicators -Assessment at a Glance

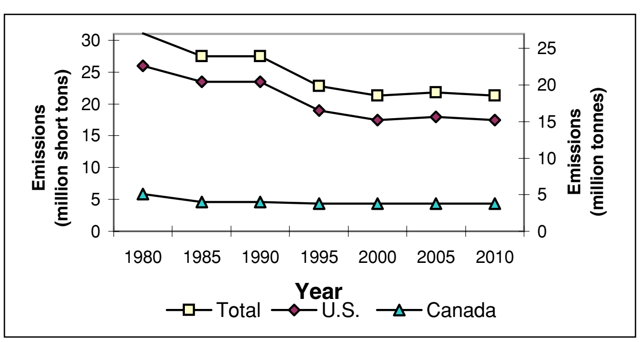


Acid Rain

Assessment: Mixed

Purpose

This indicator assesses the pH levels in precipitation and critical loadings of sulphate to the Great Lakes basin. This indicator can be used to infer the effectiveness of policies to reduce sulphur and nitrogen acidic compounds released to the atmosphere.



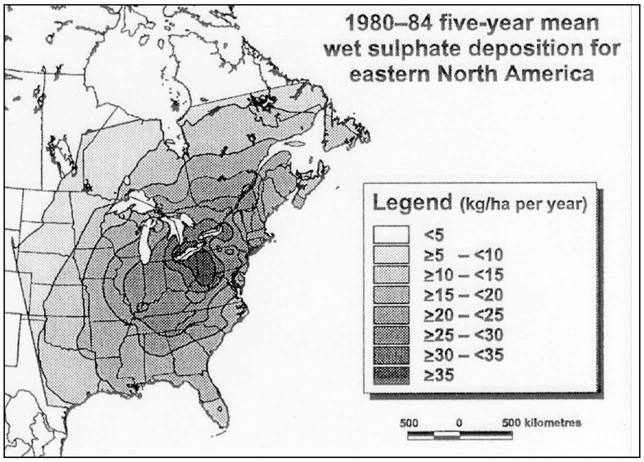
Past and predicted sulphur dioxide emissions in Canada, the U.S. and combined. Emissions after 1995 are estimates. Canadian emissions data are preliminary.

Source: Robert Vet, Meteorological Service of Canada

State of the Ecosystem

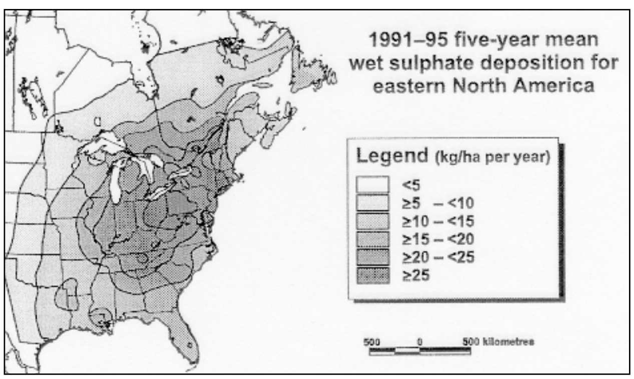
Much of the acidic precipitation in North America falls in areas around and including the Great Lakes basin. The five Great Lakes are so large that acid precipitation has little effect on them directly. Impacts mainly effect vegetation and inland lakes, especially those areas on the Canadian Shield.

SO_2 emission levels in Canada and the United States have decreased from 1980 to 1995. U.S. levels are expected to decrease by up to 40% by 2010. Canadian levels dropped 54% from 1980 to 1994 and are expected to remain at these levels. *Despite these efforts, rain is still too acidic throughout most of the Great Lakes region*. Wet sulphate deposition over eastern North America has been compared between two five-year periods, 1980-84 and 1991-95. In response to the decline in SO_2 emissions, deposition decreased between the two periods. If SO_2 emissions remain relatively constant after the year 2000, as predicted, *it is unlikely that sulphate deposition will change in the coming decade.*



Mean wet sulphate deposition in Eastern North America, 1980-1984.

Source: Robert Vet, Meteorological Service of Canada



Mean wet sulphate deposition in Eastern North America, 1991-1995.

Source: Robert Vet, Meteorological Service of Canada

Future Pressures

Population growth from both within and outside the basin may cause increased demands on electrical utility companies, natural resources and an increased number and use of motor vehicles.

Acknowledgments

Authors: Dean S. Jeffries, National Water Research Institute, Environment Canada, Burlington, ON and Robert Vet, Meteorological Service of Canada, Environment Canada, Downsview, ON.

3.8 Under Construction

From time to time, changes to the suite of Great Lakes indicators will be necessary in order to add, remove or revise indicators. Efforts are currently underway to develop an indicator to assess the status and potential impact of non-native species in the Great Lakes basin. Although details of this indicator have not yet been worked out, an example indicator report for aquatic exotic species is included here.

Exotic Species Introduced into the Great Lakes

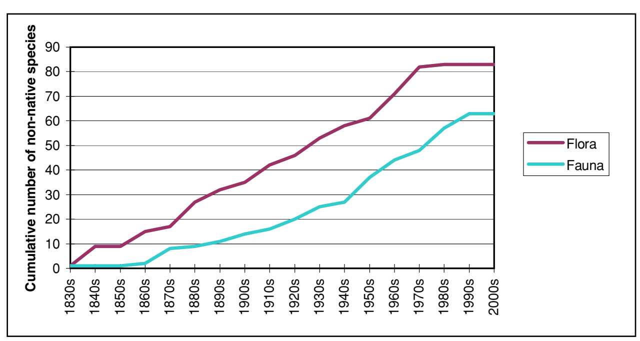
Assessment: Poor

Purpose

Currently, this indicator reports introductions of aquatic organisms not naturally occurring in the Great Lakes basin, and is used to assess the status of biotic communities in the basin. The indicator will expand to terrestrial organisms in the future.

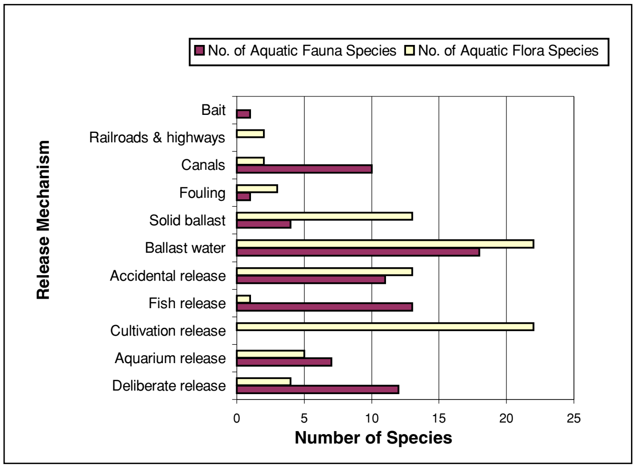
State of the Ecosystem

Since the 1830s, there have been 63 non-native aquatic animal (fauna) species introduced into the Great Lakes. Some of the main entry mechanisms include ship ballast water, the deliberate release of fish and other faunal species, and aquarium releases. In terms of aquatic plant species (flora), in almost the same timeframe there have been 83 non-native species introduced into the Great Lakes ecosystem.



Cumulative number of non-native species introduced into the Great Lakes since the 1830s.

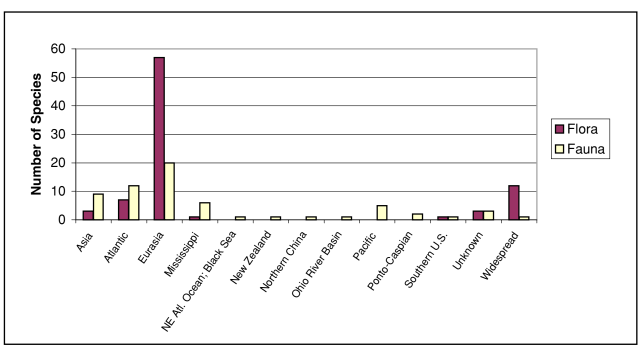
Source: E. Mills, Cornell University, NY



Release mechanisms for non-native species introduced into the Great Lakes.
Source: E. Mills, Cornell University, NY

The main entry mechanisms for aquatic plants include ship ballast water, cultivation release, aquarium releases, and solid ballast from ships.

Even with voluntary and mandatory ballast exchange programs recently implemented in Canada and the United States, new species associated with shipping activities have been reported and identified. It is essential that entry mechanisms be closely monitored and effective safeguards introduced and adjusted as necessary.



Regions of origin for non-native species established in the Great Lakes.
Source: E. Mills, Cornell University, NY

Future Pressures

Introductions of non-native species will continue because of increasing global trade; new diversions of water into the Great Lakes; aquaculture industries, such as fish farming, live food, and garden ponds; changes in water quality, temperature, and even the previous introduction of key species from outside (making the region potentially more hospitable for the establishment of new invaders).

Acknowledgments

Authors: Edward L. Mills, Department of Natural Resources, Cornell University, Bridgeport, NY and Margaret Dochoda, Great Lakes Fishery Commission, Ann Arbor, MI.